Mars Reconnaissance Orbiter

Science

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MARS EXPLORATION

The Common Thread	**Programmatic Themes**		**Resulting Knowledge**
WATER **When Where Form & Amount**	**LIFE**	*Evidence of Life: Past or Present*	**Understand the Potential for Life Elsewhere in the Universe**
	CLIMATE	*Weather Processes & Evolution*	**Understand the Processes of Climate Change**
	GEOLOGY	*Geology & Geophysics*	**Understand the Solid Planet: Its Structure and Interior**
	PREPARE FOR HUMAN EXPORATION		**Develop the Knowledge & Technology Necessary for Eventual Human Exploration**

MRO Science Definition Team (SDT): Overview

- **Chartered by J. Garvin, NASA Lead Program Scientist for Mars**
- **Co-Chaired by R. Zurek (JPL) & R. Greeley (ASU)**
- **Built on work of NASA Advisory Groups**
  - **NRC Space Studies Board Committee on Planetary & Lunar Exploration**
  - **NASA Mars Exploration Payload Advisory Group (MEPAG)**
- **Two Major Meetings Supported by Subgroup Activities**
    - **December 21, 2000 Videocon/Telecon**
    - **January 18-20, 2001 Meeting at ASU**
- **Subgroups**
    - **Atmospheres**
    - **Surface Mineralogy/Composition**
    - **Subsurface (Radar) Sounding**
    - **Imaging**
    - **Gravity & Other**
- **SDT Report submitted to J. Garvin (NASA)**
    - **Final Report (Feb. 9, 2001) submitted with cover letter Feb. 13, 2001**
    - **On NASA website:**

http://spacescience.nasa.gov/research/future.htm

MRO SDT Science Priorities (1 of 3)

- **SDT divided potential suite of high-priority science investigations (based on MEPAG report) into two groups:**
  - **Group I: Technically mature, likely to make major discoveries**
  - **Group II: Technical or scientific risk for '05, but high priority**

- ***Group I Science Objectives***
- **Recover the Mars Climate Orbiter (MCO) atmosphere and climate science objectives by characterizing:**
  - **Seasonal cycles and diurnal variations of water, dust, and carbon dioxide to understand climate processes**
    - ⇒ **Fly MARCI WAC and redesigned PMIRR**
  - **Global atmospheric structure, transport, and surface changes to elucidate factors controlling the variable distributions of water and dust**
    - ⇒ **Fly MARCI WAC, PMIRR, AO investigations**

MRO SDT Science Priorities (2 of 3)

- **Search for sites showing evidence of aqueous and/or hydrothermal activity:**
  - **Localized areas showing past aqueous mineralization**
  - **Detailed geomorphology and stratigraphy of key locales to identify formation processes of geologic features suggesting the presence of liquid water**
    - **⇒ AO investigations: VISNIR and HRI**
- **Explore in detail hundreds of targeted, globally distributed sites**
  - **Characterize in detail stratigraphy, geologic structure, composition of surface features to better understand the formation and evolution of complex terrain**
  - **Distinguish processes of eolian and non-eolian transport and surface modification**
    - **⇒ AO investigations: Context Imager, HRI and VISNIR**

MRO SDT Science Priorities (3 of 3)

- ***Group II Science Objectives***
- **Detect the presence of liquid water and determine the distribution of ground ice in the upper surface, particularly within the near-surface regolith**
  - ⇒ **Use radar to profile uppermost crust**
- **Provide atmospheric observations in addition to the MCO capabilities to further define atmospheric structure, circulation, and water vapor distribution**
  - ⇒ **Analyze data from Orbiter accelerometers during aerobraking or from radio occultations during mapping**
- **Characterize the gravity field in greater detail to understand better the geologic history and structure of the crust and lithosphere**
  - ⇒ **Analyze tracking data when orbiter is below 400 km**
- **Explore additional ways of identifying sites with high scientific potential for future Mars landed investigations**

Status of MRO Instrument Selection

- **NASA has provisionally selected the following instruments:**
  - **PMIRR-Mk II: Redesigned Mars Observer/Mars Climate Orbiter (PMIRR) Atmospheric Sounder (JPL)**
  - **MARCI+: Modified MCO Mars Color Imager (MSSS)**
    - **Wide Angle Camera for monitoring Martian weather**
    - **Medium Angle (facility) Camera for context imaging**
  - **SHARAD: Shallow subsurface RADAR for water detection (facility instrument provided by Italian Space Agency [ASI])**

- **NASA will select through an Announcement of Opportunity (to be released soon in draft form) the following:**
  - **VISNIR: Visible-near infrared imaging spectrometer**
    - **25-50 m/pixel footprints from 200 - 400 km, 0.4 - 3.6 microns**
  - **HRI: High spatial resolution imager**
    - **Monochromatic, 30-60 cm/pixel, 3-6 km swath widths from orbit altitudes of 200 – 400 km**
  - **Science Teams (*contingent on final Mission design & funding)**
    - **Radar (U.S. Members), Gravity, Accelerometer, Radio Science**

Status of MRO Instrument Selection

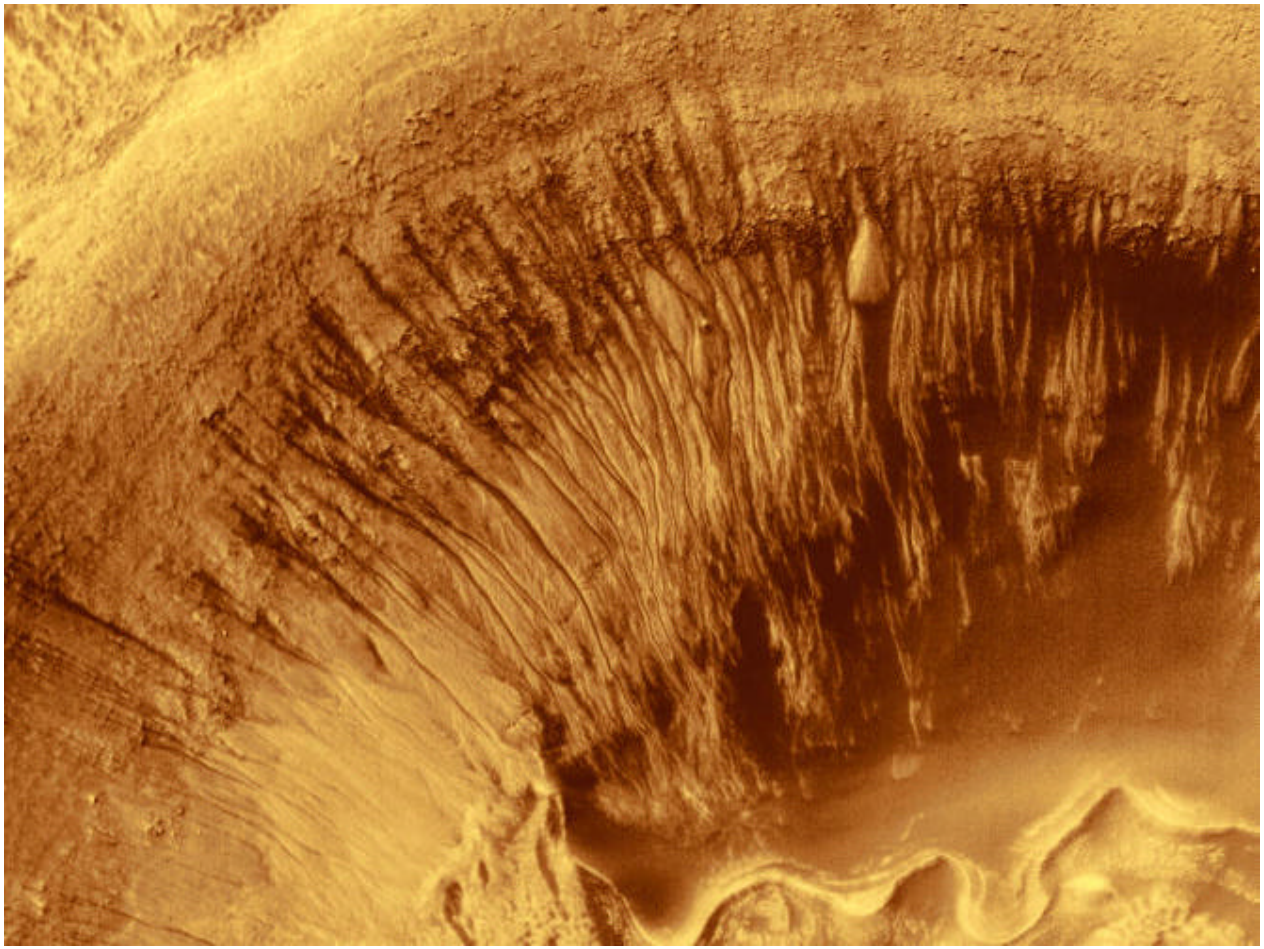
- **With regard to AO specification of Imaging Spectrometer (VISNIR) capabilities:**
  - There is an incomplete specification with regard to spectral resolution (stated to be 10 wavenumbers)
  - SDT recommended:
    - **Resolution = 10 nm at L = 2.6 microns**
      = 20 nm at L > 2.6 microns
  - SDT's intent was to ensure that the spectral resolution would be adequate to clearly detect aqueous minerals, if present on the surface of Mars. This suggested a spectral resolution in the 2-3.6 micron NIR region of

$$\lambda/\Delta\lambda \sim 250$$

Science Attributes of MRO

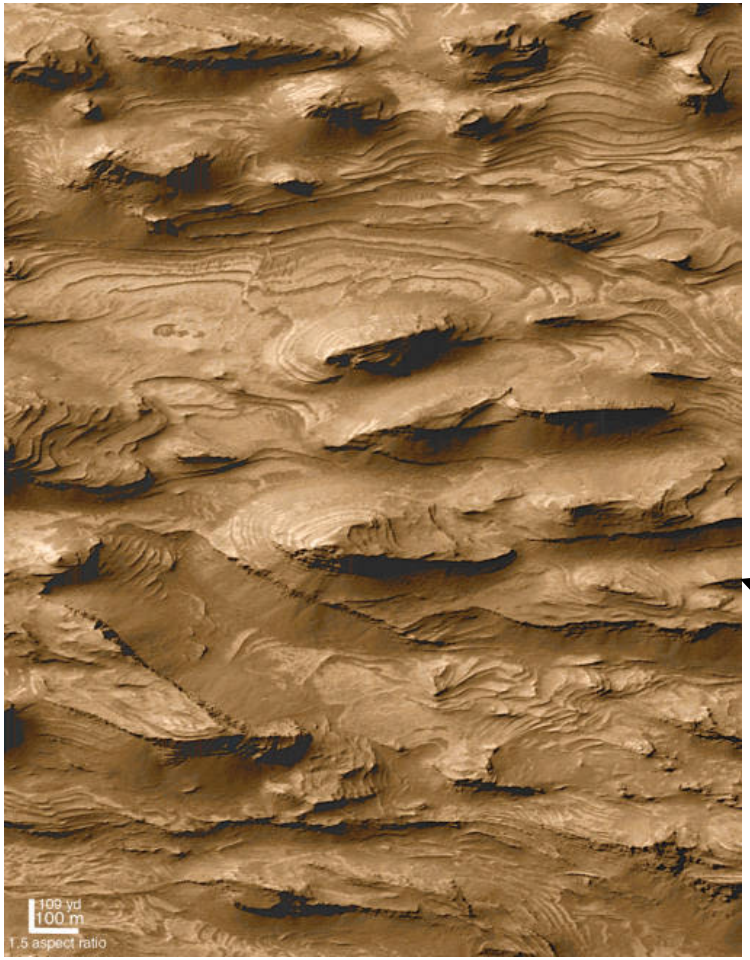
- ***Mixed Observation Modes:***
  - **Global Monitoring for one Mars year (all seasons)**
    - **MARCI WA, PMIRR-MkII**
  - **Regional Surveys of Martian Surface and Subsurface**
    - **SHARAD, MARCI MA**
  - **Targeted high spatial resolution observations**
    - **High Resolution Imager, VISNIR Imaging Spectrometer**
  - **Simultaneous Operations**
- ***Spatial resolutions unprecedented for Mars missions***
  - **Requires low altitude observing Þ 200 x 400 km orbit**
  - **Need global access Þ near-polar orbit, rotating periapsis**
  - **Need cross-track access Þ spacecraft cross-track slews**
- ***Enormous Data Volumes to be returned:***
  - **Tens of terabits of data returned during primary science mission; however,**
  - **Data return rates determine number of sites observed and fraction of Mars covered at the highest spatial resolution.**

Martian "Gullies"



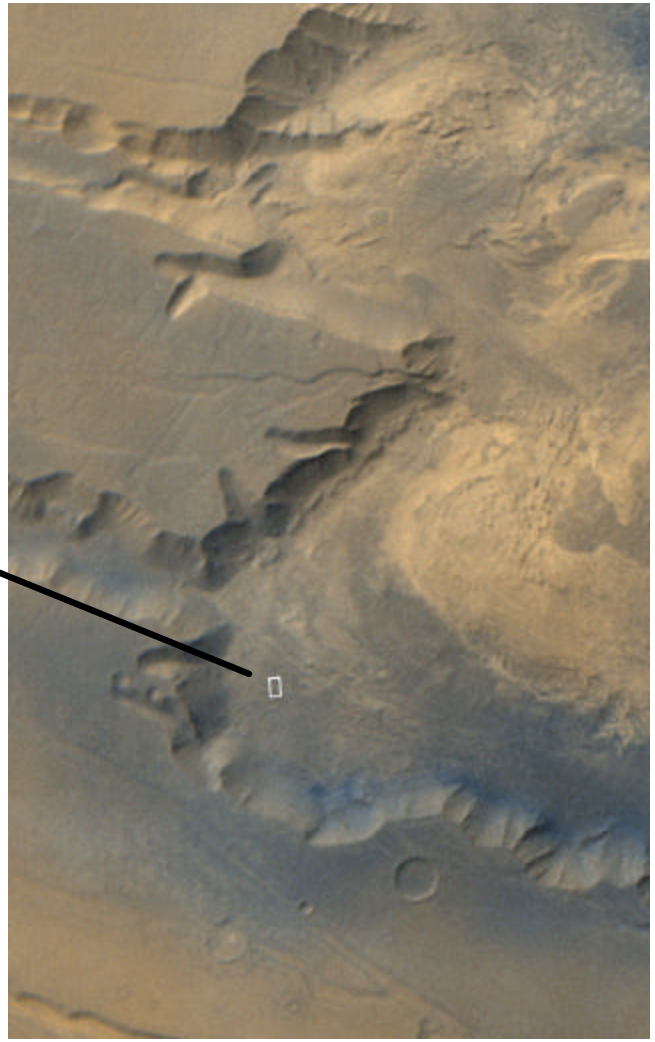
MGS MOC - MSSS

Western Candor Chasma

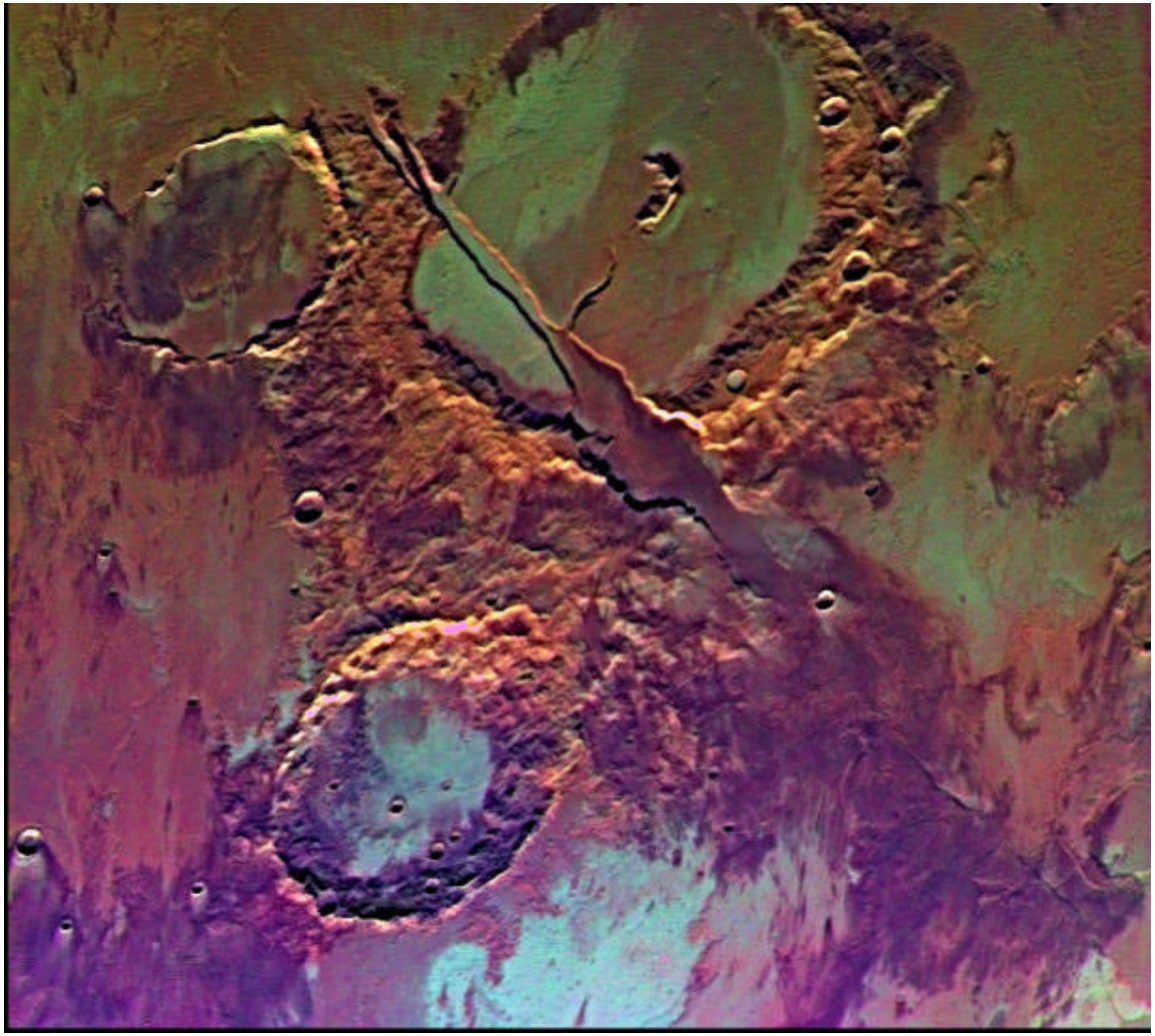


MGS MOC - MSSS

Mariner 9



Viking Color: Exploiting Spectral Data



Viking Catches a Great Dust Storm